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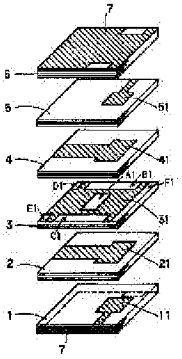
(54) LAMINATED DIELECTRIC FILTER



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a laminated dielectric filter reducing the peeling of an internal ground electrode and the characteristic dispersion caused by this exfoliation.

SOLUTION: In a laminated dielectric filter in which the resonance electrodes 21 and 41 of plural layers and the internal ground electrode 31 interposed between each resonance electrode 21 and 41 are embedded and formed in the laminated bodies of dielectric layers 1 to 6, external ground electrodes 7 are formed on the external surfaces of the laminated bodies 1 to 6 and an opening part A1 for coupling control controlling the electromagnetic coupling between the resonance electrodes 21 and 41 is formed on the internal ground electrode 31, the internal ground electrode 31 is provide with opening parts B1 to F1 facing each of four side surfaces, in addition to the opening part A1 for coupling control and a pattern is formed so that all the opening part area including the opening part A1 four coupling control may be 30% or more of filter mounting area.

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CLAIMS

[Claim(s)]

[Claim 1] Into the layered product of a dielectric, the resonance electrode of two or more layers and the internal ground electrode made to be placed between each resonance inter-electrode are embedded and formed. In the laminating mold dielectric filter with which the external ground electrode was formed in the outside surface of said layered product, and opening for combination control which controls a said resonance inter-electrode electromagnetic coupling to said internal ground electrode was formed Said internal ground electrode is shared with said opening for combination control in part apart from said opening for

combination control. The laminating mold dielectric filter characterized by carrying out pattern formation so that the full admission opening aspect product which has at least four openings distributed by facing four side faces, respectively, and includes said opening for combination control may turn into 30% or more of a filter component-side product.

[Claim 2] The laminating mold dielectric filter according to claim 1 characterized by being set up so that the area of the part which laps with said resonance electrode of said internal ground electrode may turn into 50% or more of the area of said resonance electrode.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is applied to the high pass filter carried in portable telephone etc., and relates to a useful laminating mold dielectric filter.

[0002]

[Description of the Prior Art] As a small high pass filter of several several MHz - GHz band, the dielectric filter which is made by the green sheet method and

which is constituted by carrying out the laminating of the dielectric resonator with which the resonance electrode of a predetermined pattern was formed is known. It divides roughly into this laminating mold dielectric filter, and there are a method which carries out the laminating of two or more resonators in the thickness direction, and a method which arranges two or more resonators in the same flat surface in it.

[0003] The method which piles up two or more resonators in the thickness direction has the advantage that a filter component-side product can be made small and a small filter can be obtained. In this kind of laminating mold dielectric filter, in order to optimize a resonance inter-electrode electromagnetic coupling, an internal ground electrode is made to be placed between up-and-down resonance inter-electrode, and controlling an electromagnetic coupling by opening area of this internal ground electrode is performed (for example, refer to JP,4-306005,A and JP,6-291506,A).

[0004]

[Problem(s) to be Solved by the Invention] In an above-mentioned laminating mold dielectric filter, it is easy to produce a cavity and peeling in an interface with the dielectric layer of an internal ground electrode, and dispersion arises in a filter shape by this, therefore there is a problem that the yield falls. For example, generally, when making a laminating mold dielectric filter by the green sheet method, since it is small compared with it of dielectric layers, exfoliation produces the adhesion force between an electrode and a dielectric layer between an internal electrode and a dielectric layer with the effectiveness of the springback in a sticking-by-pressure process, or the stress in the case of layered product cutting. Moreover, it originates in the difference of the coefficient of thermal expansion of an internal electrode and a dielectric layer also at the time of baking of a layered product, and the same electrode exfoliation arises too. If these exfoliation sections remain also after layered product baking, an internal cavity and a crack will arise and it will become the cause of dispersion in center frequency or pass band width by change of an effective dielectric constant.

[0005] It is easy to produce exfoliation of an internal electrode and a dielectric layer, so that a plane-of-composition product with the dielectric layer of an internal electrode is large, and since it has a big area, exfoliation tends to produce especially the internal ground electrode that controls resonance inter-electrode association. For example, since it is formed in a big area almost covering [the case of JP,4-306005,A] the whole dielectric layer surface in an internal ground electrode, it is easy to generate exfoliation. On the other hand, in the case of JP,6-291506,A, although the area of an internal ground electrode is stopped comparatively small, the internal ground electrode is drawn by two side face while it has been broad. In a lateral portion, since the effect of the stress at the time of sticking by pressure or cutting and the thermal stress at the time of baking is large, if an internal electrode is taken out to a side face while it has been broad, as for an internal ground electrode, it will especially be easy to generate exfoliation from a lateral portion.

[0006] This invention was made in consideration of the above-mentioned situation, and aims at offering the laminating mold dielectric filter which reduced property dispersion resulting from exfoliation of an internal ground electrode and this.

[0007]

[Means for Solving the Problem] The resonance electrode of two or more layers and the internal ground electrode between which it made each resonance inter-electrode placed embed this invention into the layered product of a dielectric, and it is formed. In the laminating mold dielectric filter with which the external ground electrode was formed in the outside surface of said layered product, and opening for combination control which controls a said resonance inter-electrode electromagnetic coupling to said internal ground electrode was formed Said internal ground electrode is shared with said opening for combination control in part apart from said opening for combination control. It is characterized by carrying out pattern formation so that the full admission opening aspect product which has at least four openings distributed by facing four side faces,

respectively, and includes said opening for combination control may turn into 30% or more of a filter component-side product. In this invention, preferably, it is set up so that the area of the part which laps with said resonance electrode of said internal ground electrode may turn into 50% or more of the area of said resonance electrode.

[0008] While according to this invention facing an internal ground electrode on four side faces and distributing opening, by making the numerical aperture (ratio to the filter component-side product of opening area) of an internal ground electrode into 30% or more, the adhesion of an up-and-down dielectric layer improves through opening, and it is stopped by extent which can disregard exfoliation between the internal ground electrode resulting from the stress in sticking by pressure or a cutting process, and the thermal stress in a baking process, and a dielectric layer. Moreover, since the part drawn to a side face while the internal electrode has been broad is reduced and it can connect with the external ground electrode of a side face, and a linear electrode, the crack from a lateral portion and exfoliation can be suppressed. Thereby, gap from the design value of the center of filter frequency which results from electrode exfoliation is suppressed in practically sufficient tolerance. If the numerical aperture of an internal ground electrode is set up to 40% or more, the gap from the design value of a center of filter frequency becomes small with 2% or less, and is more desirable.

[0009] If the numerical aperture of an internal ground electrode is enlarged as mentioned above, dispersion in a filter shape will be suppressed so much, but if a numerical aperture becomes large too much not much, the original function of an internal ground electrode, i.e., the function which controls an up-and-down resonance inter-electrode electromagnetic coupling, will be spoiled. Therefore, it is desirable to make area of the lapping part of a actual top and interior ground electrode and a resonance electrode into 50% or more of a resonance electrode surface product and that in other words an up-and-down resonance electrode holds down the opening area of the shape of an aperture which carries out an

electromagnetic coupling to 50% or less of a resonance electrode surface product, and controls an electromagnetic coupling optimally.

[0010]

[Embodiment of the Invention] Hereafter, the example of this invention is explained with reference to a drawing. Drawing 1 is the decomposition perspective view of the dielectric filter concerning one example of this invention, and drawing 2 is an appearance perspective view. The dielectric filter of this example carries out the laminating of the two dielectric resonators, and is constituted.

[0011] One resonator forms the stripline mold resonance electrode 21 in the front face of a dielectric layer 2, and is constituted, and another resonator forms the stripline mold resonance electrode 41 in the front face of a dielectric layer 4 too, and is constituted. The touch-down edge of the resonance electrodes 21 and 41 is arranged to the edge of dielectric layers 2 and 4, respectively, and is connected to the external ground electrode 8 formed on a side face behind a laminating as shown in drawing 2 . Among these dielectric layers 2 and 4, the dielectric layer 3 in which the internal ground electrode 31 which formed the opening A1 which controls the amount of electromagnetic couplings between two resonators was formed is pinched. The detail of the pattern of this internal ground electrode 31 is mentioned later.

[0012] There is a dielectric layer 1 by which the internal input electrode 11 combined with the resonance electrode 21 was formed in the bottom of a dielectric layer 2, and the dielectric layer 5 in which the internal output electrode 51 combined with the resonance electrode 41 was formed is on a dielectric layer 4. The internal I/O electrodes 11 and 51 are connected to the external I/O electrodes 9 and 10 formed on a side face behind a laminating, respectively as shown in drawing 2 . Under a dielectric layer 2, the dielectric layer 1 by which the external ground electrode 7 connected with the external ground electrode 8 of a side face was further formed in the underside is, and the dielectric layer 6 by which the external ground electrode 7 was similarly formed in the top face is on a

dielectric layer 5.

[0013] When making such a dielectric filter by the green sheet method concretely, according to the filter shape which should take into consideration and design the dielectric constant of the ceramic ingredient used, respectively, the sheet of required number of sheets is put on each dielectric layers 1-6. And the dielectric layers 1-6 in which each electrode mentioned above was formed are stuck by pressure in piles, a layered product is constituted, and it cuts to a predetermined filter component-side product, and in a side face, the external ground electrode 8 and the external I/O electrodes 9 and 10 are formed by print processes, and are calcinated at the end.

[0014] Drawing 3 expands and shows the pattern of the internal ground electrode 31. The aperture-like opening A has opened in the part which laps with the resonance electrode 21 shown in the internal ground electrode 31 with a broken line in drawing. This opening A1 is opening for combination control which controls the up-and-down resonance electrode 21 and the amount of electromagnetic couplings between 41. In the filter component side decided by the appearance of a dielectric layer 1, it faces on the vertical side face of drawing other than the above-mentioned opening A1 for combination control, openings B1 and C1 face a left lateral, openings D1 and E1 face a right lateral, and opening F1 is formed, respectively. and the line from which two internal ground electrodes 31 were drawn at a time by vertical 2 side face of drawing 3 -- an electrode 32 carries out pattern formation -- having -- these lines -- it connects with the external ground electrode 8 formed in a side face with an electrode 32.

[0015] In this example, in order to suppress peeling resulting from the stress in the production process of the internal ground electrode 31 etc. below to a permissible level, the rate (numerical aperture) to the filter component-side product of a total area of the opening A1 for combination control of the internal ground electrode 31 mentioned above and the other openings B1-F1 is preferably set up to 40% or more 30% or more. The concrete antecedent basis uses and explains data later. When a numerical aperture becomes large too

much, the resonance electrodes 21 and 41 come to join together by the whole surface product, and it becomes impossible on the other hand, to almost set up the optimal electromagnetic coupling required for a filter shape, although it is hard coming to separate the more the more a numerical aperture is large. Therefore, fulfilling the conditions from which the area of the part which laps with the resonance electrodes 21 and 41 of the internal ground electrode 31 turns into 50% or more of the area of the resonance electrodes 21 and 41, the magnitude of the opening A1 for combination control is chosen, and optimization of the amount of electromagnetic couplings is made.

[0016] Drawing 4 is the equal circuit of the dielectric filter by this example. The resonators 22 and 42 which consist of an LC parallel circuit of a distributed constant mold are formed with two resonance electrodes 21 and 41 by which the laminating was carried out on both sides of the internal ground electrode 31. The electromagnetic coupling of between two resonators 22 and 42 is carried out with the coupling coefficient M by the opening A1 for combination control formed in the internal ground electrode 31 as mentioned above. The capacity C31 and C32 of input/output terminals IN and OUT is each the joint capacity between the internal I/O electrodes 11 and 51 and the resonance electrodes 21 and 41.

[0017] According to this example, when it is made not to carry out termination to a side face while it has been broad, and an internal electrode 31 sets up the numerical aperture of the internal ground electrode 31 to 30% or more and makes adhesion between dielectric layers high by facing four side faces and forming openings B1, C1, D1, E1, and F1 dispersively, dispersion in a filter shape is suppressed in the range permitted practically.

[0018] Drawing 5 is the appearance perspective view of the dielectric filter concerning another example of this invention. The same sign as drawing 1 is given to drawing 1 and a corresponding part, and detailed explanation is omitted. Although the resonance electrodes 21 and 41 are bent, it is considering as the pattern and the pattern of the internal ground electrode 31 and the internal I/O electrodes 11 and 51 differs from drawing 1 in connection with this in this

example, the basic configuration is the same as that of drawing 1 . Drawing 6 expands and shows the pattern of the internal ground electrode 31 in this example. Four side faces other than the resonance electrode 21 and the opening A2 for combination control which controls the electromagnetic coupling between 41 are faced, and opening B-2, and C2, D2 and E2 are prepared in the internal ground electrode 31, respectively. The numerical aperture of the internal ground electrode 31 is set up like the above-mentioned example.

[0019] Also according to the example of drawing 5 , the same effectiveness as a previous example is acquired. The example of drawing 5 shows the concrete antecedent-basis data with which dispersion in a filter property is suppressed to drawing 8 and drawing 9 . Using the electrode pattern of the example of drawing 5 , the magnitude of opening for combination control of an internal ground electrode keeps the design value of a filter shape constant as center frequency f0=1900[MHz] fractional-band-width RBW=0.947, and these are the results of measuring the center frequency and fractional band width when changing various numerical apertures, and show Maximum MAX, the minimum value MIN, and the average AV about 64 measurement sizes of each numerical aperture.

[0020] If the data of drawing 8 and drawing 9 are seen and it will become small from it bordering on 30% of numerical apertures, the gap from center frequency and the design value of fractional band width and dispersion will become large rapidly. This is based on the internal cavity and crack by electrode exfoliation in each part as the area of an internal ground electrode becomes large. At 30% of numerical apertures, about 3.5%, the gap from the design value of fractional band width is about 13%, and the gap from the design value of the center frequency average serves as an excellent article practically satisfactory. At 40% of numerical apertures, the gap from the design value of the center frequency average is about 2%, and also when a high performance property is required, it can fully meet the demand.

[0021] opening B-2 which drawing 7 is the example which transformed the pattern of drawing 6 a little, and faces the opening A2 for combination control in

drawing 6 , and the side face on it -- one -- it collects and considers as opening A3. Moreover, the part to which the opening C2 which faces a lower side face also laps with the resonance electrodes 21 and 41 in part is used as opening for combination control. Also according to this example, the same effectiveness as a previous example is acquired.

[0022]

[Effect of the Invention] By considering as the structure which prepared opening so that an internal ground electrode may not be derived on a side face in the dielectric filter which is constituted by carrying out the laminating of the resonance electrode of two or more layers on both sides of an internal ground electrode according to this invention, while it has been broad as stated above, and carrying out optimal setting out of the numerical aperture, exfoliation of an internal ground electrode can be controlled and dispersion in a filter shape can be reduced.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view of the dielectric filter

concerning one example of this invention.
[Drawing 2] It is the appearance perspective view of the dielectric filter of this example.
[Drawing 3] It is drawing showing the internal ground electrode pattern of the dielectric filter of this example.
[Drawing 4] It is the equal circuit of the dielectric filter of this example.
[Drawing 5] It is the decomposition perspective view of the dielectric filter concerning other examples of this invention.
[Drawing 6] The internal ground electrode pattern of the dielectric filter of this example is shown.
[Drawing 7] The internal ground electrode pattern of the example which transformed drawing 6 is shown.
[Drawing 8] It is the measurement data in which the numerical aperture of an internal ground electrode and the relation of center frequency are shown.
[Drawing 9] It is the measurement data in which the numerical aperture of an internal ground electrode and the relation of fractional band width are shown.
[Description of Notations]
1-6 [-- An internal ground electrode, 51 / -- 7 An internal output electrode, 8 / -- An external ground electrode, 9 / -- An external input electrode, 10 / -- An external output electrode, A1, A2 / -- Opening for combination control, B1-F1 B-2-E2 / -- Opening.] -- A dielectric layer, 11 -- 21 An internal input electrode, 41 -- A resonance electrode, 31

[Translation done.]

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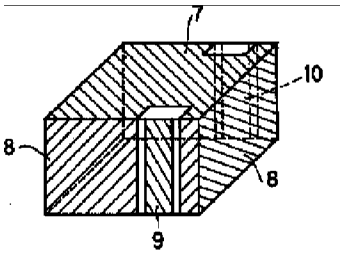
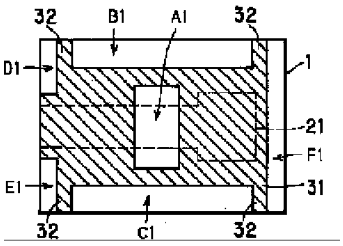
DRAWINGS

[Drawing 2]



[Drawing 3]



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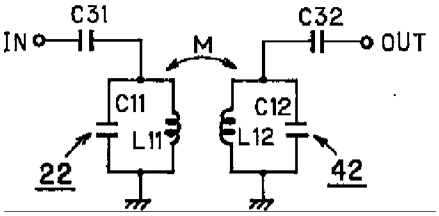
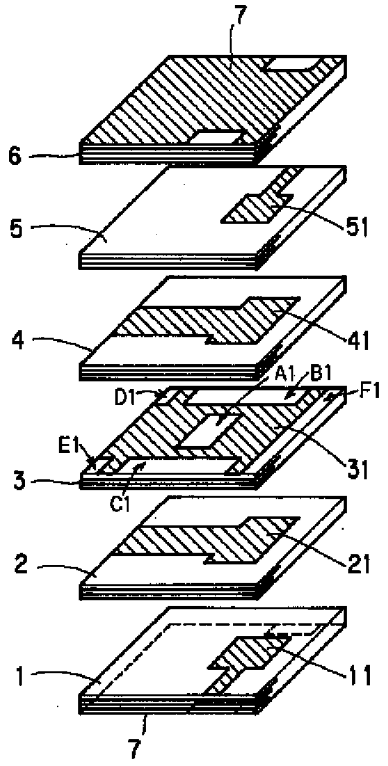
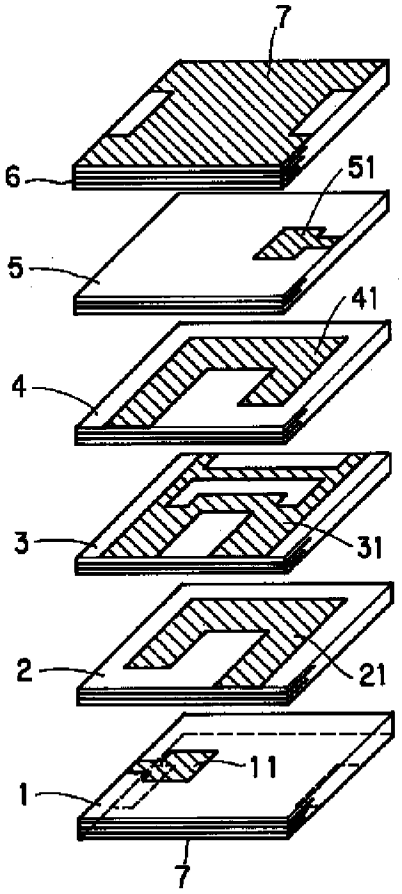


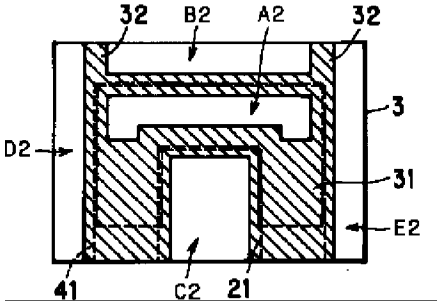
[Drawing 1]



[Drawing 5]



[Drawing 6]



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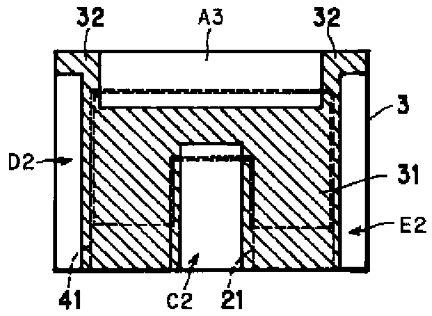
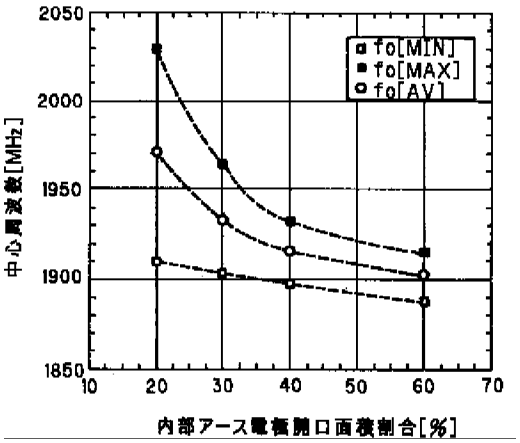
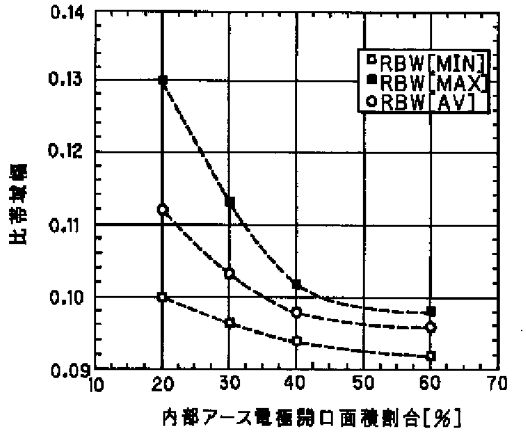


[Drawing 8]



[Drawing 9]



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Ｈ０１Ｐ	1/203		Ｈ０１Ｐ	1/203	
	1/205			1/205	Ｂ
					Ｈ
	5/08			5/08	Ｈ
	7/08			7/08	

審査請求　未請求　請求項の数２　ＯＬ　（全 ６ 頁）

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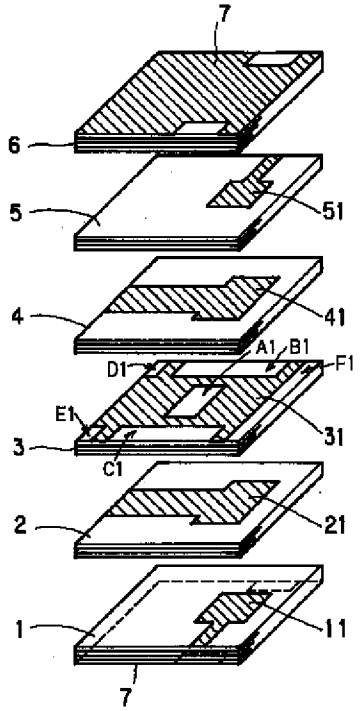
最終頁に続く

(54)【発明の名称】　積層型誘電体フィルタ

(57)【要約】

【課題】　内部アース電極の剥離およびこれに起因する特性ばらつきを低減した積層型誘電体フィルタを提供する。

【解決手段】　誘電体層１～６の積層体中に、複数層の共振電極２１，４１と、各共振電極２１，４１間に介在させた内部アース電極３１が埋め込み形成され、積層体の外面に外部アース電極が形成され、内部アース電極３１に共振電極２１，４１間の電磁結合を制御する結合制御用開口部Ａ１が形成された積層型誘電体フィルタにおいて、内部アース電極３１には、結合制御用開口部Ａ１と別に、４つの側面にそれぞれ面して開口部Ｂ１～Ｆ１が設けられ、かつ結合制御用開口部Ａ１を含めた全開口部面積がフィルタ実装面積の３０％以上となるようにパターン形成されている。



【特許請求の範囲】
【請求項１】　誘電体の積層体中に、複数層の共振電極と、各共振電極間に介在させた内部アース電極とが埋め込み形成され、前記積層体の外面に外部アース電極が形成され、前記内部アース電極に前記共振電極間の電磁結合を制御する結合制御用開口部が形成された積層型誘電体フィルタにおいて、
前記内部アース電極は、前記結合制御用開口部と別に、または前記結合制御用開口部と一部共用して、４側面にそれぞれ面して分散配置された少なくとも４つの開口部を有し、かつ前記結合制御用開口部を含めた全開口部面積がフィルタ実装面積の３０％以上となるようにパターン形成されていることを特徴とする積層型誘電体フィルタ。
【請求項２】　前記内部アース電極の前記共振電極と重なる部分の面積が前記共振電極の面積の５０％以上となるように設定されていることを特徴とする請求項１記載の積層型誘電体フィルタ。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、携帯用電話機等に搭載される高周波フィルタに適用して有用な積層型誘電体フィルタに関する。
【０００２】
【従来の技術】数ＭＨｚ～数ＧＨｚ帯の小型高周波フィルタとして、グリーンシート法により作られる、所定パターンの共振電極が形成された誘電体共振器を積層して構成される誘電体フィルタが知られている。この積層型誘電体フィルタには、大別して、複数の共振器を厚み方向に積層する方式と、同一平面内に複数の共振器を配設する方式とがある。
【０００３】複数の共振器を厚み方向に重ねる方式は、フィルタ実装面積を小さくして小型フィルタを得ることができるという利点を持つ。この種の積層型誘電体フィルタにおいては、共振電極間の電磁結合を最適化するため、上下の共振電極間に内部アース電極を介在させ、この内部アース電極の開口部面積により電磁結合を制御することが行われる（例えば、特開平４－３０６００５号公報、特開平６－２９１５０６号公報参照）。
【０００４】
【発明が解決しようとする課題】上述の積層型誘電体フィルタにおいては、内部アース電極の誘電体層との界面に空洞や剥がれが生じ易く、これによりフィルタ特性にばらつきが生じ、従って歩留まりが低下するという問題がある。例えばグリーンシート法で積層型誘電体フィルタを作る場合、一般に電極と誘電体層の間の密着力は誘電体層同士のそれに比べて小さいため、圧着工程でのスプリングバックの効果や積層体切断の際の応力により、内部電極と誘電体層との間に剥離が生じる。また、積層体の焼成時にも内部電極と誘電体層の熱膨張率の差に起因して、やはり同様の電極剥離が生じる。これらの剥離部が積層体焼成後にも残れば、内部空洞や割れが生じ、実効誘電率の変化により中心周波数や通過帯域幅のばらつきの原因となる。
【０００５】内部電極と誘電体層の剥離は、内部電極の誘電体層との接合面積が大きいほど生じ易く、特に共振電極間の結合を制御する内部アース電極は大きな面積を持つために剥離が生じ易い。例えば、特開平４－３０６００５号の場合、内部アース電極はほぼ誘電体層全面にわたる大きな面積で形成されているため、剥離が発生し易い。一方、特開平６－２９１５０６号の場合、内部アース電極の面積は比較的小さく抑えられているが、内部アース電極は幅広のまま２側面に導出されている。側面部では特に圧着や切断時の応力、焼成時の熱応力の影響が大きいため、内部電極を幅広のまま側面まで取り出すと、内部アース電極は側面部から剥離が発生し易い。
【０００６】この発明は、上記事情を考慮してなされたもので、内部アース電極の剥離およびこれに起因する特性ばらつきを低減した積層型誘電体フィルタを提供することを目的としている。
【０００７】
【課題を解決するための手段】この発明は、誘電体の積層体中に、複数層の共振電極と、各共振電極間に介在させた内部アース電極とが埋め込み形成され、前記積層体の外面に外部アース電極が形成され、前記内部アース電極に前記共振電極間の電磁結合を制御する結合制御用開口部が形成された積層型誘電体フィルタにおいて、前記内部アース電極は、前記結合制御用開口部と別に、または前記結合制御用開口部と一部共用して、４側面にそれぞれ面して分散配置された少なくとも４つの開口部を有し、かつ前記結合制御用開口部を含めた全開口部面積がフィルタ実装面積の３０％以上となるようにパターン形成されていることを特徴としている。この発明において好ましくは、前記内部アース電極の前記共振電極と重なる部分の面積が前記共振電極の面積の５０％以上となるように設定される。
【０００８】この発明によると、内部アース電極には４側面に面して開口部を分散配置すると共に、内部アース電極の開口率（開口部面積のフィルタ実装面積に対する比率）を３０％以上とすることにより、開口部を介して上下の誘電体層の密着性が向上し、圧着や切断工程での応力、焼成工程での熱応力に起因する内部アース電極と誘電体層の間の剥離が無視できる程度に抑えられる。また、内部電極が幅広のまま側面まで導出される部分を減らし、側面の外部アース電極と線状の電極により接続できるため、側面部からの割れや剥離を抑えることができる。これにより、電極剥離に原因するフィルタ中心周波数の設計値からのズレが実用上十分な許容誤差範囲に抑えられる。内部アース電極の開口率を４０％以上に設定すれば、フィルタ中心周波数の設計値からのズレは２％

以下と小さくなり、より好ましい。

【０００９】上述のように内部アース電極の開口率を大きくすれば、それだけフィルタ特性のばらつきは抑えられるが、余り開口率が大きくなりすぎると内部アース電極の本来の機能、即ち上下の共振電極間の電磁結合を制御する機能が損なわれる。従って実際上、内部アース電極と共振電極との重なる部分の面積を共振電極面積の５０％以上とすること、言い換えれば、上下の共振電極が電磁結合する窓状の開口部面積を共振電極面積の５０％以下に抑えて電磁結合を最適制御することが好ましい。

【００１０】

【発明の実施の形態】以下、図面を参照して、この発明の実施例を説明する。図１は、この発明の一実施例に係る誘電体フィルタの分解斜視図であり、図２は外観斜視図である。この実施例の誘電体フィルタは、二つの誘電体共振器を積層して構成されている。

【００１１】一つの共振器は、誘電体層２の表面にストリップライン型共振電極２１を形成して構成され、もう一つの共振器は誘電体層４の表面にやはりストリップライン型共振電極４１を形成して構成されている。共振電極２１，４１の接地端はそれぞれ誘電体層２，４の端部まで配設されて、図２に示すように積層後に側面に形成される外部アース電極８に接続される。これら誘電体層２，４の間には、二つの共振器間の電磁結合量を制御する開口部Ａ１を設けた内部アース電極３１が形成された誘電体層３が挟まれている。この内部アース電極３１のパターンの詳細は後述する。

【００１２】誘電体層２の下には、共振電極２１に結合する内部入力電極１１が形成された誘電体層１があり、誘電体層４の上には共振電極４１に結合する内部出力電極５１が形成された誘電体層５がある。内部入出力電極１１，５１はそれぞれ、図２に示すように積層後に側面に形成される外部入出力電極９，１０に接続される。誘電体層２の下には更に、側面の外部アース電極８につながる外部アース電極７が下面に形成された誘電体層１があり、誘電体層５の上には同様に外部アース電極７が上面に形成された誘電体層６がある。

【００１３】具体的にこの様な誘電体フィルタをグリーンシート法により作る場合、各誘電体層１～６にはそれぞれ用いるセラミック材料の誘電率を勘案して設計すべきフィルタ特性に応じて必要な枚数のシートを重ねる。そして上述した各電極が形成された誘電体層１～６を重ねて圧着して積層体を構成し、所定のフィルタ実装面積に切断し、側面には外部アース電極８および外部入出力電極９，１０を印刷法により形成して、最後に焼成する。

【００１４】図３は、内部アース電極３１のパターンを拡大して示す。内部アース電極３１には図に破線で示す共振電極２１と重なる部分に、窓状の開口部Ａが開けられている。この開口部Ａ１が、上下の共振電極２１，４１間の電磁結合量を制御する結合制御用開口部である。誘電体層１の外形で決まるフィルタ実装面内には上述の結合制御用開口部Ａ１の他に、図の上下側面に面して開口部Ｂ１，Ｃ１が、左側面に面して開口部Ｄ１，Ｅ１が、右側面に面して開口部Ｆ１がそれぞれ形成されている。そして、内部アース電極３１は、図３の上下２側面に２本ずつ導出された線状電極３２がパターン形成され、これらの線状電極３２により側面に形成される外部アース電極８に接続される。

【００１５】この実施例においては、内部アース電極３１の製造工程での応力等に起因する剥がれを許容レベル以下に抑えるために、上述した内部アース電極３１の結合制御用開口部Ａ１およびその他の開口部Ｂ１～Ｆ１のトータルの面積のフィルタ実装面積に対する割合（開口率）が、３０％以上、好ましくは４０％以上に設定される。その具体的な根拠は後にデータを用いて説明する。一方、開口率は大きければ大きいほど、剥がれにくくなるが、開口率が大きくなりすぎると共振電極２１，４１が殆ど全面積で結合するようになり、フィルタ特性に必要な最適な電磁結合を設定できなくなる。従って、内部アース電極３１の共振電極２１，４１と重なる部分の面積が共振電極２１，４１の面積の５０％以上となる条件を満たしながら、結合制御用開口部Ａ１の大きさを選んで、電磁結合量の最適化がなされる。

【００１６】図４は、この実施例による誘電体フィルタの等価回路である。内部アース電極３１を挟んで積層された二つの共振電極２１，４１により、分布定数型のＬＣ並列回路からなる共振器２２，４２が形成されている。二つの共振器２２，４２間は、前述のように内部アース電極３１に形成された結合制御用開口部Ａ１により、結合係数Ｍで電磁結合されている。入出力端子ＩＮ，ＯＵＴの容量Ｃ３１，Ｃ３２はそれぞれ内部入出力電極１１，５１と共振電極２１，４１の間の結合容量である。

【００１７】この実施例によると、内部電極３１が、４側面に面して分散的に開口部Ｂ１，Ｃ１，Ｄ１，Ｅ１，Ｆ１を設けることによって、幅広のまま側面に終端しないようにし、かつ内部アース電極３１の開口率を３０％以上に設定して誘電体層間の密着性を高くすることにより、フィルタ特性のばらつきが実用上許容される範囲に抑えられる。

【００１８】図５は、この発明の別の実施例に係る誘電体フィルタの外観斜視図である。図１と対応する部分には図１と同一符号を付して詳細な説明は省く。この実施例では、共振電極２１，４１を折り曲げパターンとしており、これに伴って内部アース電極３１、内部入出力電極１１，５１のパターンが図１と異なっているが、基本構成は図１と同様である。図６は、この実施例での内部アース電極３１のパターンを拡大して示している。内部アース電極３１には、共振電極２１，４１間の電磁結合

を制御する結合制御用開口部Ａ２の他に、４つの側面に面してそれぞれ開口部Ｂ２，Ｃ２，Ｄ２，Ｅ２が設けられている。内部アース電極３１の開口率は上記実施例と同様に設定される。

【００１９】図５の実施例によっても、先の実施例と同様の効果が得られる。図５の実施例により、フィルタ特性のばらつきが抑えられる具体的な根拠データを図８および図９に示す。これらは、図５の実施例の電極パターンを用いて、フィルタ特性の設計値を中心周波数ｆ０＝１９００［ＭＨｚ］、比帯域幅ＲＢＷ＝０．９４７として、内部アース電極の結合制御用開口部の大きさは一定に保って、開口率を種々変えたときの、中心周波数および比帯域幅を測定した結果であり、各開口率のサンプル数６４個について、最大値ＭＡＸと最小値ＭＩＮおよび平均値ＡＶを示している。

【００２０】図８および図９のデータを見ると、開口率３０％を境にしてそれより小さくなると、中心周波数および比帯域幅の設計値からのズレおよびばらつきが急激に大きくなる。これは、内部アース電極の面積が大きくなるにつれて各部での電極剥離による内部空洞や割れによるものである。開口率３０％では、中心周波数平均値の設計値からのズレは約３．５％、比帯域幅の設計値からのズレは約１３％であり、実用上問題なく良品となる。開口率４０％では、中心周波数平均値の設計値からのズレは約２％であり、高性能特性が要求される場合にも十分にその要求に応えることができる。

【００２１】図７は、図６のパターンを若干変形した実施例であり、図６における結合制御用開口部Ａ２とその上の側面に面する開口部Ｂ２とを一つのまとめて、開口部Ａ３としたものである。また下側の側面に面する開口部Ｃ２も、一部共振電極２１，４１に重なる部分が結合制御用開口部として用いられている。この実施例によっても、先の実施例と同様の効果が得られる。

【００２２】

【発明の効果】以上述べたようにこの発明によれば、複数層の共振電極を内部アース電極を挟んで積層して構成される誘電体フィルタにおいて、内部アース電極を、幅広のまま側面に導出しないように開口部を設けた構造とし、かつ開口率を最適設定することによって、内部アース電極の剥離を抑制してフィルタ特性のばらつきを低減することができる。

【図面の簡単な説明】

【図１】　この発明の一実施例に係る誘電体フィルタの分解斜視図である。

【図２】　同実施例の誘電体フィルタの外観斜視図である。

【図３】　同実施例の誘電体フィルタの内部アース電極パターンを示す図である。

【図４】　同実施例の誘電体フィルタの等価回路である。

【図５】　この発明の他の実施例に係る誘電体フィルタの分解斜視図である。

【図６】　同実施例の誘電体フィルタの内部アース電極パターンを示す。

【図７】　図６を変形した実施例の内部アース電極パターンを示す。

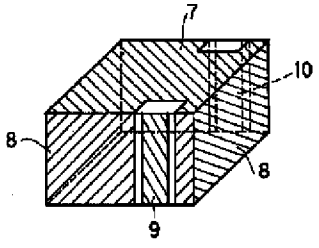
【図８】　内部アース電極の開口率と中心周波数の関係を示す測定データである。

【図９】　内部アース電極の開口率と比帯域幅の関係を示す測定データである。

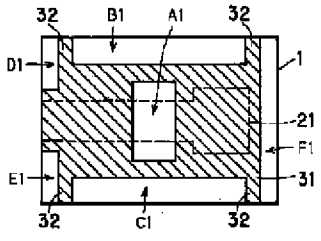
【符号の説明】

１～６…誘電体層、１１…内部入力電極、２１，４１…共振電極、３１…内部アース電極、５１…内部出力電極、７，８…外部アース電極、９…外部入力電極、１０…外部出力電極、Ａ１，Ａ２…結合制御用開口部、Ｂ１～Ｆ１，Ｂ２～Ｅ２…開口部。

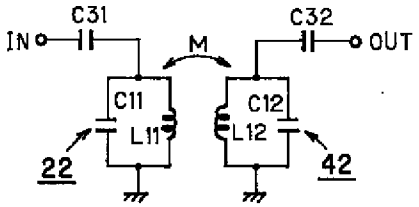
【図２】



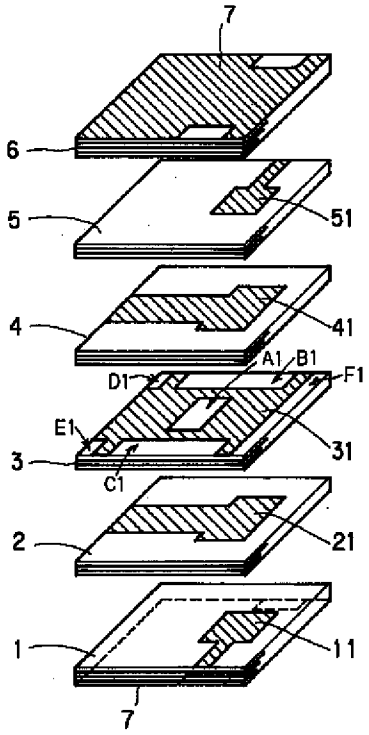
【図３】



【図４】



【図１】


7
6
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51
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A1
B1
D1
F1
E1
31
3
C1
2
21
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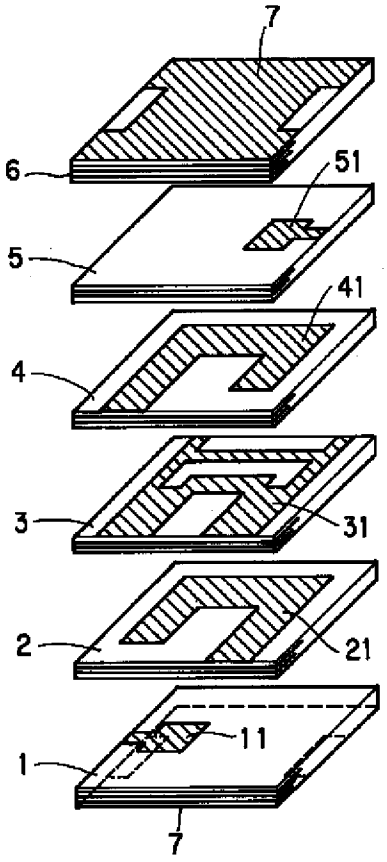
11
7

【図５】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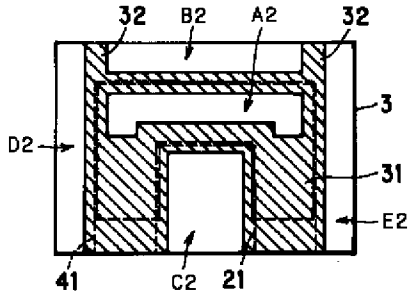
【図６】


32
B2
A2
32
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D2
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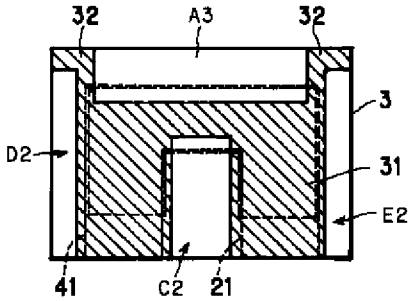
E2
41
C2
21

【図７】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A3
32
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D2
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E2
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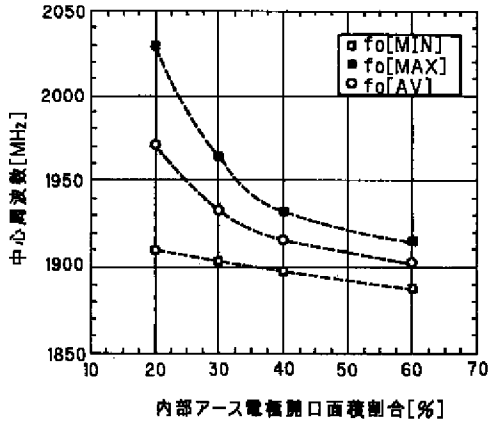
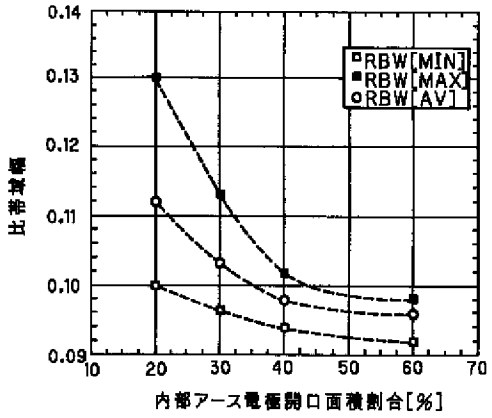
C2
21

【図８】



【図９】



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